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G.I.-30 SEPT. 1976

GEOCRES No. 30M12-154

DIST. 6 REGION

W.P. No. 127-66-27

CONT. No. 82-106

W. O. No.

STR. SITE No. 24-81-184D

HWY. No. 401

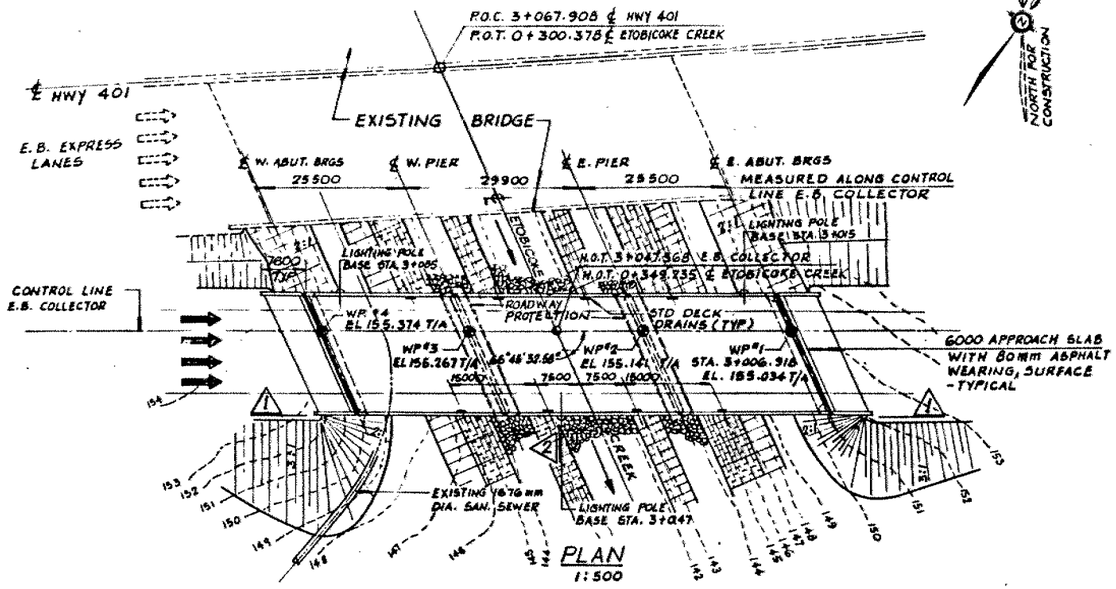
LOCATION Bridge #8, EB Collector Over Etobicoke Cr.

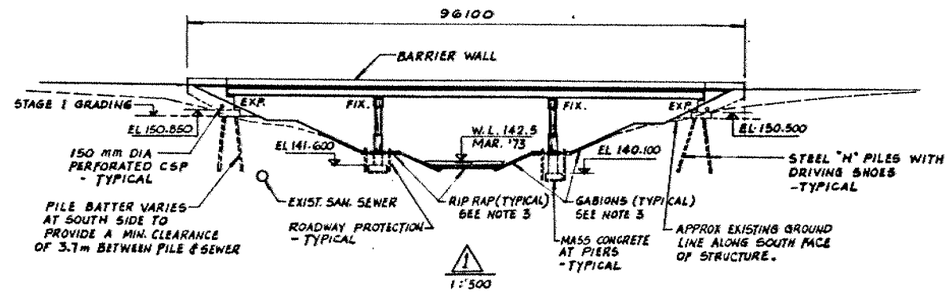
No of PAGES - —

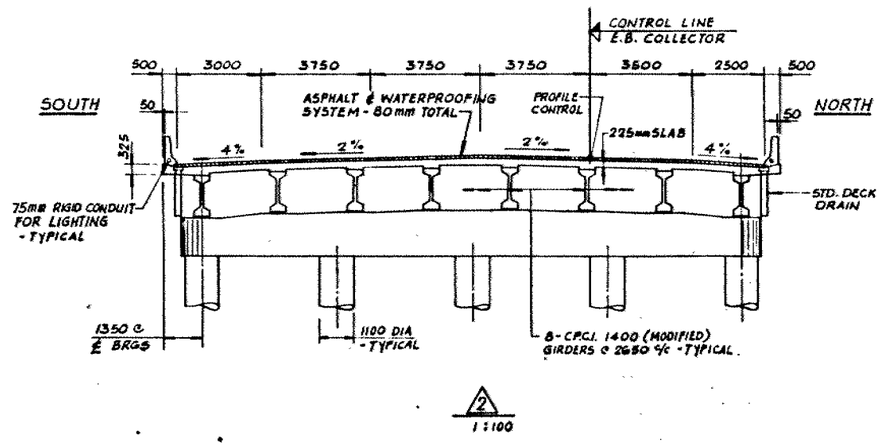
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

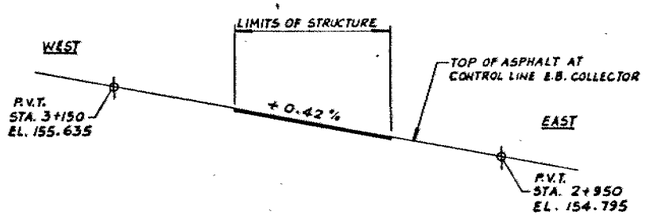
REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DS-SR 1241 81-44









PROFILE OF E.B. COLLECTOR
N.T.S.

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

NOTE
1. W/P DENOTES WORKING POINT
2. T/A DENOTES TOP OF ASPHALT PAVEMENT
3. SEE GRADING DWGS FOR LIMIT OF EXISTING AND PROPOSED CHANNEL PROTECTION.
4. SEE GRADING DRAWINGS FOR RESTORATION OF EXISTING RIP RAP AND CHANNEL PROTECTION.

DISTR. 6
CONT No
WP No 127-66-27

BRIDGE NO. 8 - HWY 401 E.B. COLLECTOR OVER ETOBICOKE CREEK
GENERAL ARRANGEMENT

SHEET

DelCan DE LEUW CATHER CANADA LTD
CONSULTING ENGINEERS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE
PRESTRESSED CONCRETE GIRDERS ——— 40 MPa
FOOTINGS & APPROACH SLABS ——— 20 MPa
REMAINDER ——— 30 MPa

REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLEAR COVER TO REINFORCING STEEL
FOOTINGS ——— 100 ± 25mm
PIERS AND FRONT FACE OF ABUTMENTS AND WINGWALLS ——— 80 ± 20mm
BOTTOM OF DECK ——— 40 ± 10mm
REMAINDER ——— 70 ± 20mm
UNLESS OTHERWISE NOTED.

CONSTRUCTION NOTES
COMPACTED FILL, MAX GRAIN SIZE 75mm SHALL BE PLACED UP TO THE BOTTOM OF FOOTING ELEVATION PRIOR TO DRIVING PILES.

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3m.m.

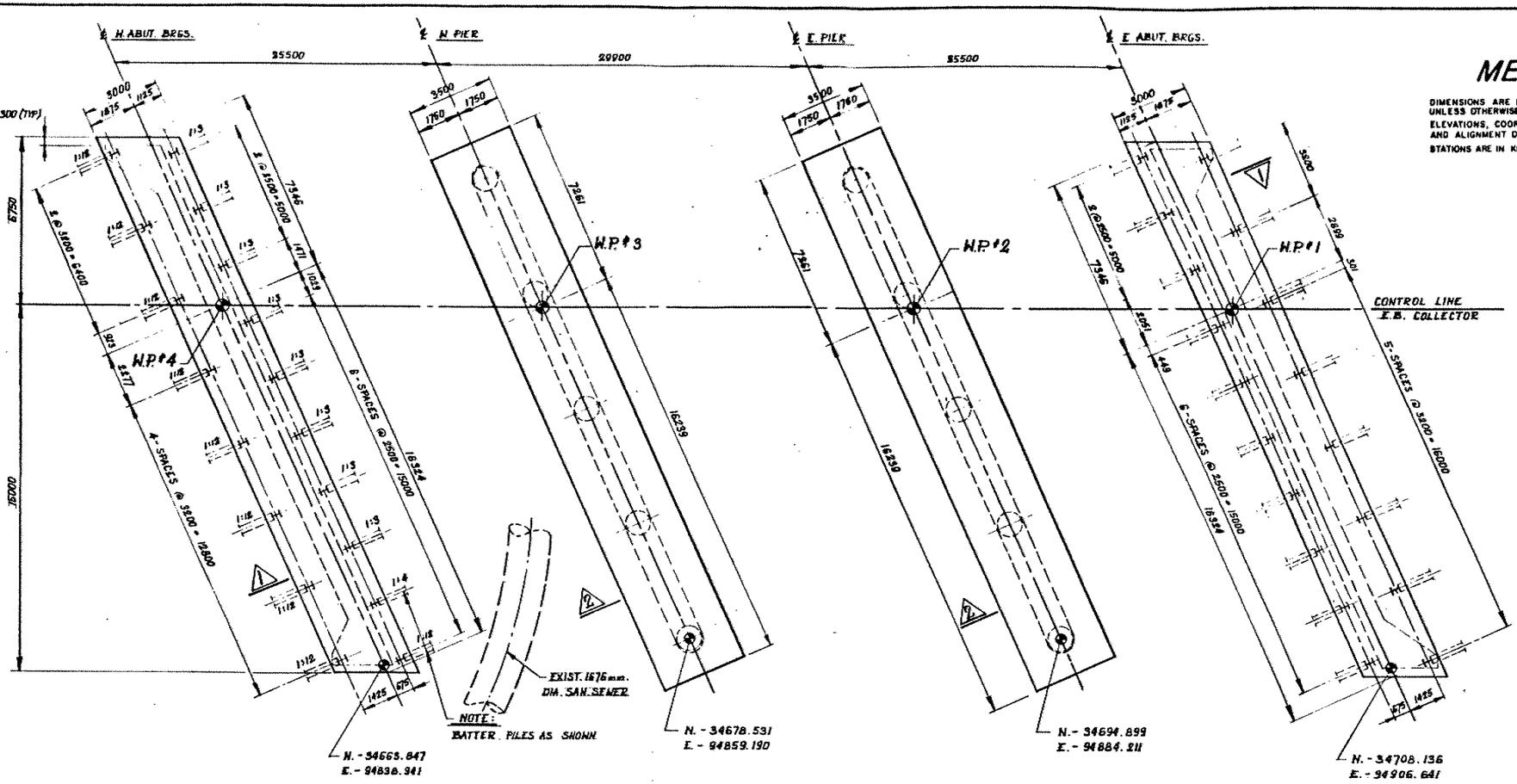
LIST OF DRAWINGS

REGISTERED PROFESSIONAL ENGINEER M. E. FRIESEN PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
NO.	DATE	BY	DESCRIPTION
DESIGN BRF	CHECK GSS	LOADING ONBDC-A-79	DATE MAY 82
DRAWING DHS	CHECK GSS	SITE 24-81-184D	DWG 1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DESIGN INST 81-06



METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 127-66-27

SHEET

BRIDGE NO. 8 - HWY 401 E.B. COLLECTOR OVER ETOBICOKE CREEK
FOUNDATION LAYOUT

DeLCan DE LEUW CATHER CANADA LTD.
CONSULTING ENGINEERS AND PLANNERS

NOTE

MASS CONCRETE TO BE PLACED WITHIN 3 HOURS OF EXCAVATION FOR PIER FOUNDATIONS.

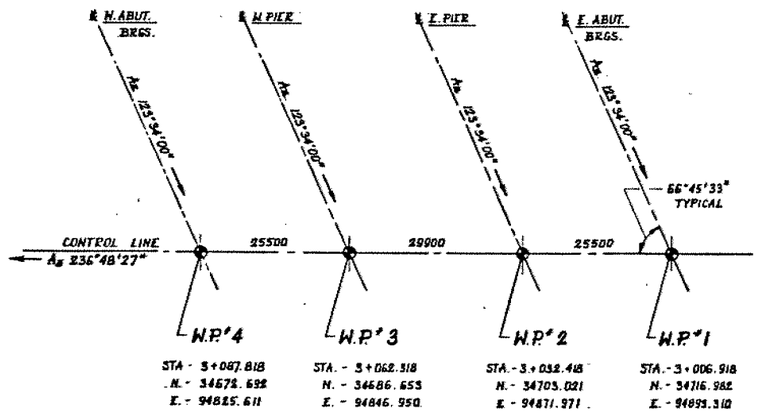
PILE NOTES

1. PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 103-10 OR SS 103-11.
2. PILE DRIVING ENERGY DELIVERED SHALL NOT BE LESS THAN 48000 JOULES PER BLOW.
3. PILE SPACING TO BE MEASURED AT THE UNDERSIDE OF FOOTINGS.
4. PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATIONS.
5. FOR DETAILS OF DRIVING SHOES SEE STANDARD DD 3501.
6. PILE DESIGN DATA
   CAPACITY AT S.L.S. TYPE II = 1000 kN
   FACTORED CAPACITY AT U.L.S. = 1650 kN
7. PILE CONSTRUCTION DATA
   ULTIMATE CAPACITY = 3000 kN.

STEEL PILE DATA			
LOCATION	Nº REQD.	LGTH. mm	TYPE
EAST ABUTMENT	18	10200	HP 310 × 110 WITH DRIVING SHOES
WEST ABUTMENT	18	10000	HP 310 × 110 WITH DRIVING SHOES

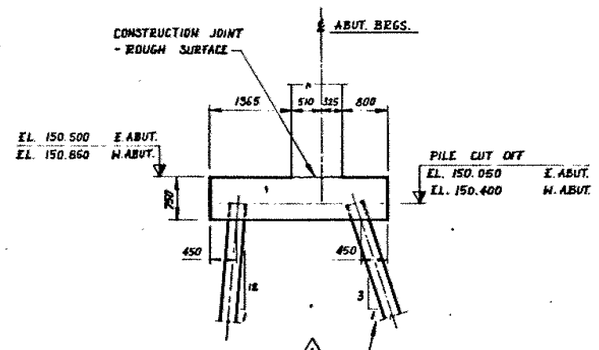
FOUNDATION PLAN

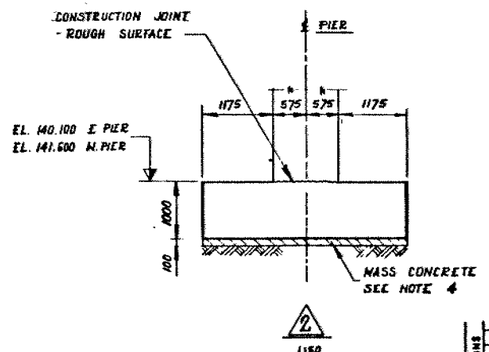
N.T.S.



LOCATION OF WORKING POINTS

N.T.S.





DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

R. D. POWER
P.Eng.
PROVINCE OF ONTARIO

REVISIONS		
	DATE	BY
		DESCRIPTION

DESIGN RDP	CHECK BRF	LOADING OHBDC-A-78	DATE MAY 82	
DRAWING WK	CHECK BRF	SITE 24-81-184 D	DWG 3	

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

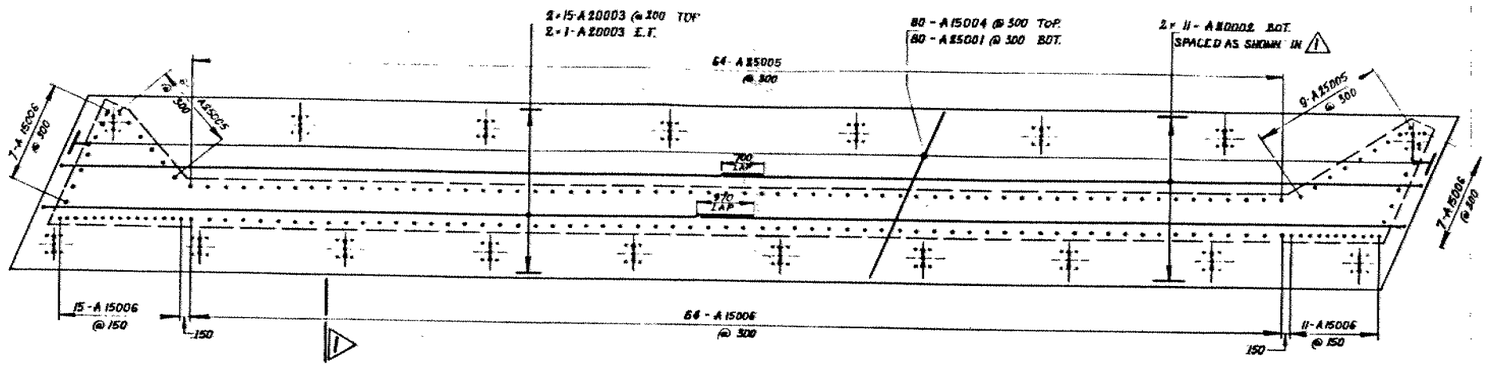
CONT No
WP No 127-66-27

BRIDGE NO. 8 - HWY 401 E.B.
COLLECTOR OVER ETOBICOKE CREEK
FOOTING REINFORCEMENT

SHEET

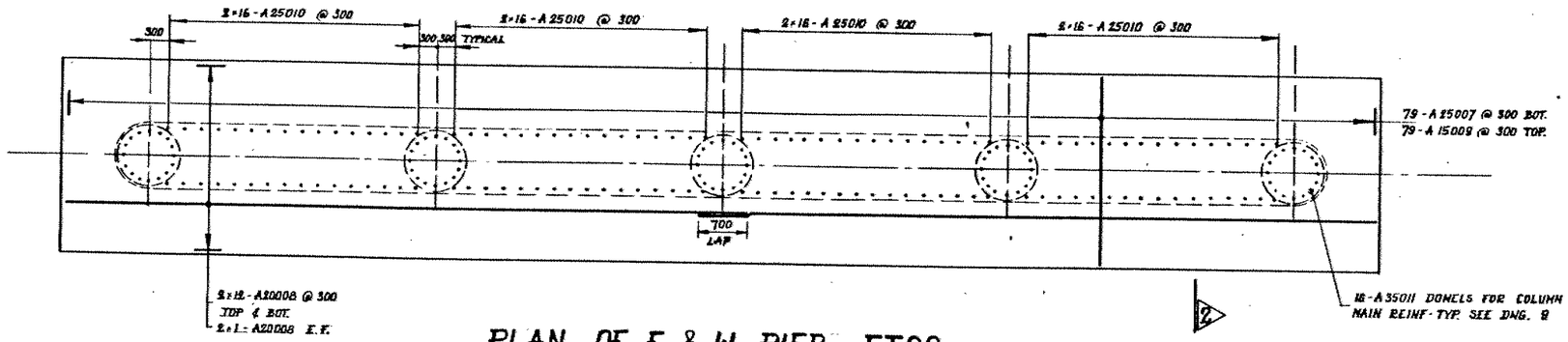
DeLCan DE LEUW CATHER CANADA LTD.
CONSULTING ENGINEERS AND PLANNERS

NOTE
E.F. DENOTES EACH FACE.



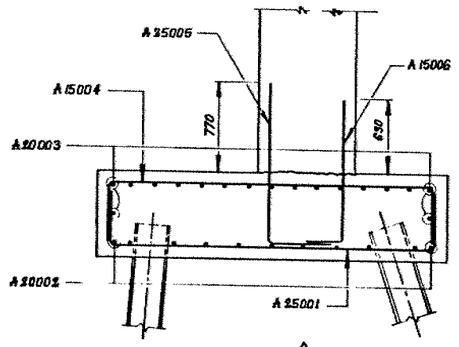
PLAN OF E. & W. ABUT. FTGS.

1:50



PLAN OF E. & W. PIER FTGS.

1:50



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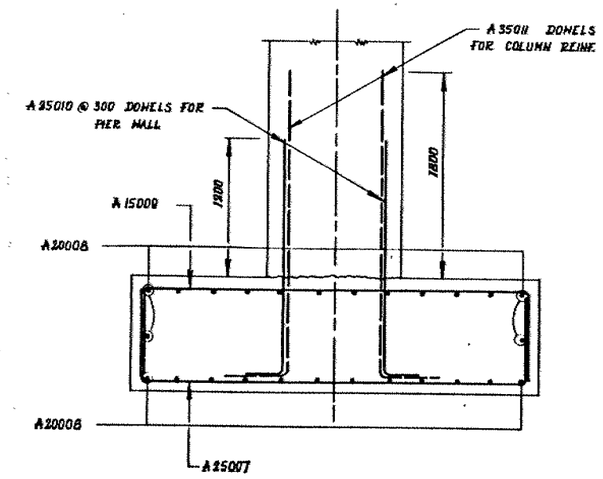

2

1:25

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

R. D. POWER
PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN R.D.P.	CHECK BEF	LOADING OHBDC-A-79	DATE MAY 66
DRAWING M.K.	CHECK BEF	SITE 22-81-164 D	DWG 4

CONT B2-106

Ontario

Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 127-66-27 DIST 6

HWY 401 STR SITE 24-81-184D

Bridge #8, Highway 401 E.B. Collector
Over Etobicoke Creek

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GEOCRES 30M12-154 DATE

APR 14 1982

FOUNDATION INVESTIGATION REPORT

For

Bridge #8

Highway 401 E.B. Collector

Over Etobicoke Creek

W.P. 127-66-27, Site 24-81-184D

Hwy. 401, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks.

The fieldwork was carried out in two stages:

i) a total of 5 sampled borings (BH#1 to #4 and #21), four accompanied by dynamic cone penetration tests, were originally advanced between 73-03-01 and 73-11-14 as part of the field investigation for the existing Bridge #9, Hwy. 401 Core over Etobicoke Creek. Subsequently a Foundation Report was issued under W.P. 127-66-28 dated 73-05-29 and the bridge constructed under Contract 74-109. These borings ranged in depth from 4.6 to 13.1 metres, with bedrock being cored in all borings for a maximum depth 4.9 metres.

ii) The second stage of the field investigation consisted of 4 sampled borings (BH #101 to #104) advanced between 82-01-13 and 82-01-22 for depths ranging from 5.6 to 19.7 metres. Bedrock was augered in all boreholes and cored in one for 2.3 metres.

SITE DESCRIPTION AND GEOLOGY

The area under investigation is located at the crossing of Hwy. 401 and Etobicoke Creek in the City of Mississauga, Regional Municipality of Peel. Topographically, the area can best be described as a broad plain with the Etobicoke Creek cutting deep into the overburden. The resulting valley is approximately 125 metres wide with a depth of 12.5 metres. The

land is primarily used for farming purposes, with Toronto International Airport located immediately north of the site.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation is composed of a cohesive glacial till whose thickness is quite variable. In the region, the Credit River, Oakville and Etobicoke Creeks have cut deep valleys into the overburden. There is, therefore, no large undrained depression, swamp or bog in this area although in many of the interstream areas drainage is still imperfect.

The overburden is underlain by grey shale bedrock of the Meaford-Dundas formation, Ordovician Period.

Subsurface Conditions

In general, the extent and composition of the overburden is uniform across the site. The predominate natural surficial deposit is a cohesive glacial till consisting of silty clay with sand and varying amounts of gravel extending for a maximum thickness of 5.1 metres during the recent investigation. Borings in the vicinity of the creek channel encountered a fluvial deposit composed of sand and gravel with fines for a maximum thickness of 3.1 metres during the initial investigation. In boreholes put down through the approach embankments of the existing Etobicoke Creek Bridge, fill material up to 10.1 metres thick, composed of the parent glacial till material of the area was found to overly the till and/or shale bedrock. Weathered shale bedrock was encountered in all borings at elevations ranging from 139.9 to 141.7.

The boundaries between the various soil types as encountered at the time of investigation, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings along with a profile and four estimated stratigraphical sections based on borehole data, are shown on Drawing No. 1276627-A.

The various soil types encountered are briefly described in the following paragraphs.

Embankment Fill Material

Borings advanced through the existing approach embankments indicate the fill material to be predominately derived from the parent glacial till of the area, consisting of a silty clay of low plasticity with some sand and varying amounts of gravel. This fill was encountered for thicknesses ranging from 3.7 to 10.1 metres at the abutment locations, and some 1.2 metres at the pier locations during the recent field investigation.

Typical grainsize distribution curves for the cohesive fill material are plotted on Figure 1. Results of water content and Atterberg Limit testing on recent samples are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		Range	Average
Water Content	(w) %	13-20	15
Liquid Limit	(W_L) %	33-39	37
Plastic Limit	(W_p) %	16-20	18
Plasticity Index	(I_p) %	15-20	19

These results indicate the matrix of the cohesive fill to be an inorganic silty clay of low to intermediate plasticity (CL-CI).

Based on Standard Penetration Test 'N' values generally averaging 10 to 12 blows/0.3 metre, it is estimated that the fill material has undergone a relatively moderate degree of compaction.

Silty Clay, Sand, and Gravel (Glacial Till)

The natural surficial deposit across the site is a glacial till composed of silty clay of low plasticity with sand and varying amounts of gravel. As a result of previous construction activity, this till is often reworked and difficult to distinguish from the overlying derived embankment fill material. Where identified in the recent investigation, it ranges from 1.7 to 5.1 metres in thickness, and contains an increasing frequency of fragments and detached slabs of weathered shale and limestone in it's lower portion.

Results of identity testing of recent samples (plotted on the Plasticity Chart, Figure 3) indicate the cohesive matrix of the till material to consist of a inorganic silty clay of low plasticity (CL). Typical grain size distribution curves for this deposit are shown on Figure 4.

Based on interpretation of 'N' values ranging 14 to in excess of 100 blows per 0.3 metres and augering operation, the consistency of this deposit ranges from stiff to hard.

Sand and Gravel Alluvium

Three of the borings carried out for the initial investigation identified an alluvial deposit composed of sand and gravel with traces of silt and clay sized particles, ranging in thickness from 2.1 to 3.1 metres. Based on interpretation of 'N' values the denseness of this river deposit ranges from loose to dense. This material was not encountered in the recent investigation.

Bedrock

Bedrock surface was encountered immediately below the glacial till and embankment fill material at depths corresponding to elevations ranging from 140.5 to 140.8 during the recent investigation. These elevations closely relate to elevations of 139.9 to 141.7 encountered during the earlier investigation. The surface of bedrock appears to be relatively flat across the site and can be expected to exhibit minor undulations across the footing locations.

Based on visual examination of BXL rock cores, bedrock is described as a thin to medium bedded dark grey shale with occasional thin layers of limestone and silty limestone of the Dundas Formation. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock. The depth of weathering varied from 0.7 metres to in excess of 3 metres across the site.

Groundwater Conditions

Readings of stabilized water levels taken in open boreholes, indicate a water table ranging between elevations 140.9 and 142.1. This elevation roughly corresponds with the creek water level, and can be expected to fluctuate accordingly.

DISCUSSION AND RECOMMENDATION

In order to accomodate the upgrading of Hwy. 401 west of Hwy. 427 to a collector/core network, East and West Bound Collector Bridges over Etobicoke Creek are required. The proposed E.B. structure (Bridge #8) will be designed as a 3 span (27 - 33 - 25 metres) concrete girder structure with a total width of 20 metres, accomodating 4 driving lanes and 2 break down lanes. A proposed Hwy. 401 E.B. Collector profile grade of 155.5 and Etobicoke Creek bed of some 142 will necessitate approach fills in the order of 13.5 metres, however a majority of these approach embankments have been in place since 1974 as part of the adjacent core structure construction.

In consideration of the proximity of competent weathered shale bedrock to original ground surface across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as follows:

STRUCTURE FOUNDATIONS

Abutments

Considering the height of the approach embankment, abutments elements should be perched within the approach fills and supported on end-bearing piles driven into the weathered bedrock. Assuming a 110HP310 steel 'H' section pile equipped with the standard M.T.C. reinforced tips (welded flange plates) and driven to a minimum set of 15 blows/25mm for the last 75 mm with a hammer capable of delivering a minimum energy of 48,000 joules/blow, the following design parameters are recommended

Factor Capacity at U.L.S.	1650 kN
Capacity at S.L.S. Type II	1000 kN
Ultimate Capacity	3000 kN

Based on the previously mentioned pile driving criteria, piles should penetrate to the following minimum tip elevations.

West Abutment	Elev. 140.5
East Abutment	Elev. 140.0

Gradation of fill in the zone of pile penetration should be restricted to a maximum size of 75 mm.

Piers

In consideration of the proximity of weathered bedrock to the creek bottom, it is recommended that the proposed piers be supported on spread footings founded within the weathered shale bedrock. For footings founded at or below elevation 139.0 for the east pier and elevation 140.5 for the west pier within the weather shale zone the following design parameters are given

Factored Capacity at U.L.S.	1000 kPa
Capacity at S.L.S. Type II	Not Applicable

In order to insure minimum settlement of footings, the base of footing excavations into the weathered shale should be covered with a thin working slab of lean concrete immediately after the completion of the footing excavations.

A minimum of 1.3 metres of earth cover is required for frost protection considerations for all footings and pier pile caps.

Embankment Stability and Settlement

No deep seated rotational/sliding-type of movement are anticipated considering the proximity of competent till and level bedrock surface beneath the embankment. However, due to the high fill heights contemplated, stability of the embankment material itself is of concern. Stability analysis of the fill based in terms of total and effective stresses as carried out for the original report indicate that for fills ranging in height from 10.6 to 13.7 metres will be stable with 3:1 slopes in both the longitudinal and transverse direction. Alternatively, standard 2:1 slopes with a mid height beam of sufficient length so that the overall slope is not steeper than 3:1 is acceptable.

The toe of the embankments should be protected from future scour action by the use of an adequately designed riprap scheme.

All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill.

In addition, all new fill material should be properly benched in the existing slopes as per current M.T.C. standards.

In order to minimize post construction maintenance problems as a result of settlements within the embankment fill material, it is recommended that fills be constructed and left in place for as long a period as possible prior to final grading and paving operations.

Other Considerations

Provided backfill to the abutments consists of free draining granular material and adequate provisions are made for an appropriate drainage scheme, the following equivalent fluid pressures may be assumed for computation of earth pressures.

a) At ultimate limit state

- active condition	8.0 kPa/m
- at rest condition	10.0 kPa/m

b) At serviceability limit state

- active condition	6.5 kPa/m
- at rest condition	8.5 kPa/m

To ensure the placement of pier footings "in the dry", maintain the integrity of the existing creek banks and prevent softening and/or undermining of the existing Bridge #9 pier footings, it will be necessary to carry out the excavations for the new pier foundations within a sheeted cofferdam or alternatively, a staged braced excavation carried out in conjunction with creek flow diversion. However, pumping from sumps will be required to control water infiltration in either schemes. Anticipated driving depths of steel sheeting is no greater than weathered shale surface with possible refusal being met within the fragmented shale and limestone zone in the glacial till.

Temporary cut slopes for placement of abutment piles will be stable at a 1.5:1 geometry, however care must be exercised not to disturb or undermine the existing Bridge #9 abutment pile cap.

MISCELLANEOUS

The fieldwork for the original investigation (dated 73-03) was carried out under the supervision of Mr. V. Korlu, Project Foundations Engineer. The recent fieldwork was supervised by Mr. V. Parker, Field Technician, utilizing equipment owned and operated by Atcost Soil Drilling, Concord.

This report was written by Mr. T. J. Kazmierowski, Foundation Engineer, and reviewed by Mr. M. Devata, Senior Foundations Engineer.

T. J. Kazmierowski, P. Eng.
Foundation Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 665.4; E 294 832.4 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test and BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 01 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
144.0	Ground Surface										
0.0	Sand and Gravel traces of Silty Clay Loose to Compact		1	SS	5						
			2	SS	11		142				
	Shale Fragments		3	SS	100/15 cm						
140.9											
3.1	Grey Weathered Shale Bedrock		4	RC BXL	47% REC						
			5	RC BXL	99% REC		140				
			6	RC BXL	100% REC						
137.3							138				
6.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 682.1; E 294 853.8 ORIGINATED BY V.K.
DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & BXL Rock Core COMPILED BY J.B.
DATUM Geodetic DATE 1973 03 02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
143.4	Ground Surface										
0.0	Sand and Gravel traces of Silt		1	SS	21						
	Compact		2	SS	16		142				56 31 (13)
140.7			3	SS	160/25 cm			100/15 cm			
2.7			4	AS	-		140				
	Weathered										
	Shale Bedrock Sound		5	RC BXL	100% REC		138				
135.8			6	RC BXL	100% REC		136				
7.6	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 699.5; E 294 876.6 ORIGINATED BY V.K.

DIST 6 HWY 401 BOREHOLE TYPE Auger Cone Test & BXL Rock Core COMPILED BY J.B.

DATUM Geodetic DATE 1973 03 07 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
143.5	Ground Surface										
0.0	(Glacial Till) Silty Clay, with Sand and Gravel Hard		1	SS	34				○		
141.7							142	100/20 cm			
1.8	Grey Shale Bedrock		2	BXL	45%						
			3	RC BXL	17% REC						
	Weathered		4	RC BXL	36% REC		140				
	Intact		5	RC BXL	94% REC						
137.8							138				
5.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 715.7; E 294 898.6 ORIGINATED BY V.K.

DIST 6 HWY 401 BOREHOLE TYPE Auger, Cone Test & EXL Rock Core COMPILED BY J.B.

DATUM Geodetic DATE 1973 03 02 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.3	Ground Surface										
0.0	Fill Silty Clay, traces of Sand, Gravel & organics		1	SS	8	▼	150				
148.8	Stiff										
1.5	(Glacial Till) Silty Clay, Sand and Gravel Very Stiff to Hard		2	SS	27		148	100/15 cm	○		5 31 53 11
			3	SS	77						
			4	SS	79				○		15 37 43 5
			5	SS	100/15 cm		146				
	with detached slabs and fragments of weathered Shale and Limestone		6	SS	100/13 cm				○		
			7	SS	100/10 cm		144				
			8	SS	100/8 cm						
			9	SS	100/10 cm		142				
139.9											
10.4	Grey Weathered Shale Bedrock		10	RC BXL	25% REC		140				
			11	RC BXL	77% REC		138				
137.2											
13.1	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 3 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 21

METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 692.2; E 294 838.2 ORIGINATED BY J.B.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger & Rock Core COMPILED BY J.B.

DATUM Geodetic DATE 1973 11 14 CHECKED BY GP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
143.0	Ground Surface										
0.0	Sand and Gravel trace of Silt Compact to Dense		1	SS	26	▼	142				
140.9			2	SS	38						
2.1	Grey Weathered Shale Bedrock occ. bands of Limestone		3	SS	100/13 cm		140				
			4	SS	50/5 cm						
138.4			5	RC	70% REC						
4.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 101

METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 697.7; E 294 910.0 ORIGINATED BY V.P.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY V.P.

DATUM Geodetic DATE 82 01 13 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.3	Ground Surface										
0.0	Fill (Reworked Glacial Till) Silty Clay some Sand trace of Gravel stiff to very stiff		1	SS	10		148				7 19 40 34
			2	SS	11						
			3	SS	10	▼					
145.6			4	SS	17		146				
3.7	Grey (Glacial Till) Silty Clay some Sand trace of Gravel with fragments of Shale and Limestone Hard		5	SS	40						
			6	SS	49		144				
			7	SS	60						
140.5			8	SS	53		142				
8.8	Grey Weathered Shale Bedrock occasional thin layers of Limestone		9	SS	100/5 cm		140				
			10	SS	100/15 cm						
			11	RC BXL	REC 98%		138				
135.6			12	RC	REC 100%		136				
13.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 102 METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 690.0; E 294 888.6 ORIGINATED BY V.P.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.

DATUM Geodetic DATE 82 01 20 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
143.6	Ground Surface										
0.0	(Glacial Till) Silty Clay with Sand, trace of Gravel stiff to very stiff Brown / Grey		1	SS	15		142		○		9 28 39 24
			2	SS	14						
140.5	Shale fragments		3	SS	24	▼			○		
3.1	Grey Shale Bedrock		4	SS	48		140				
			5	SS	41				○		
			6	SS	63						
	Weathered						138				
	occ. thin layers of Limestone		7	SS	100/0 cm						
135.7							136				
7.9	Refusal to augers on intact bedrock. End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 103

METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 688.2; E 294 844.3 ORIGINATED BY V.P.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.

DATUM Geodetic DATE 82 01 21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
143.6	Ground Surface										
0.0	Fill										
	Reworked Till and										
142.4	Concrete Slabs										
1.2	(Glacial Till)										
	Silty Clay with Sand		1	SS	26	▽	142				
	and Shale fragments										
140.7	Very Stiff to Hard		2	SS	127				○		
2.9	Grey		3	SS	130						
	Weathered						140				
	Shale Bedrock		4	SS	120/18 cm				○		
			5	SS	100/9 cm						
138.0											
5.6	Refusal to Augers on intact bedrock. End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 104 METRIC

W P 127-66-27 LOCATION Co-ords. N 4 834 668.8; E 294 811.7 ORIGINATED BY V.P.
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 82 01 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
154.1	Ground Surface										
0.0	Fill (Reworked glacial till) Silty Clay, some Sand varying amounts of Gravel		1	SS	7	*	154				
			2	SS	11						
			3	SS	67		152		○		26 18 38 18
			4	SS	12						
	Angular Shale and Limestone fragments		5	SS	11		150		○		24 12 39 25
			6	SS	19						
	Firm to very stiff		7	SS	14		148		○		11 13 43 33
			8	SS	27		146				
144.0			9	SS	29				○		19 20 38 23
10.1	(Glacial Till) Silty Clay, some Sand varying amounts of Gravel		10	SS	43		144				
	Very stiff to Hard		11	SS	28		142				
140.8											
13.3	Grey		12	SS	126/20 cm		140				
	Weathered		13	SS	110/13 cm		138				
	Shale Bedrock with thin layers of Limestone		14	SS	100/8 cm		136				
134.4											
19.7	End of Borehole										

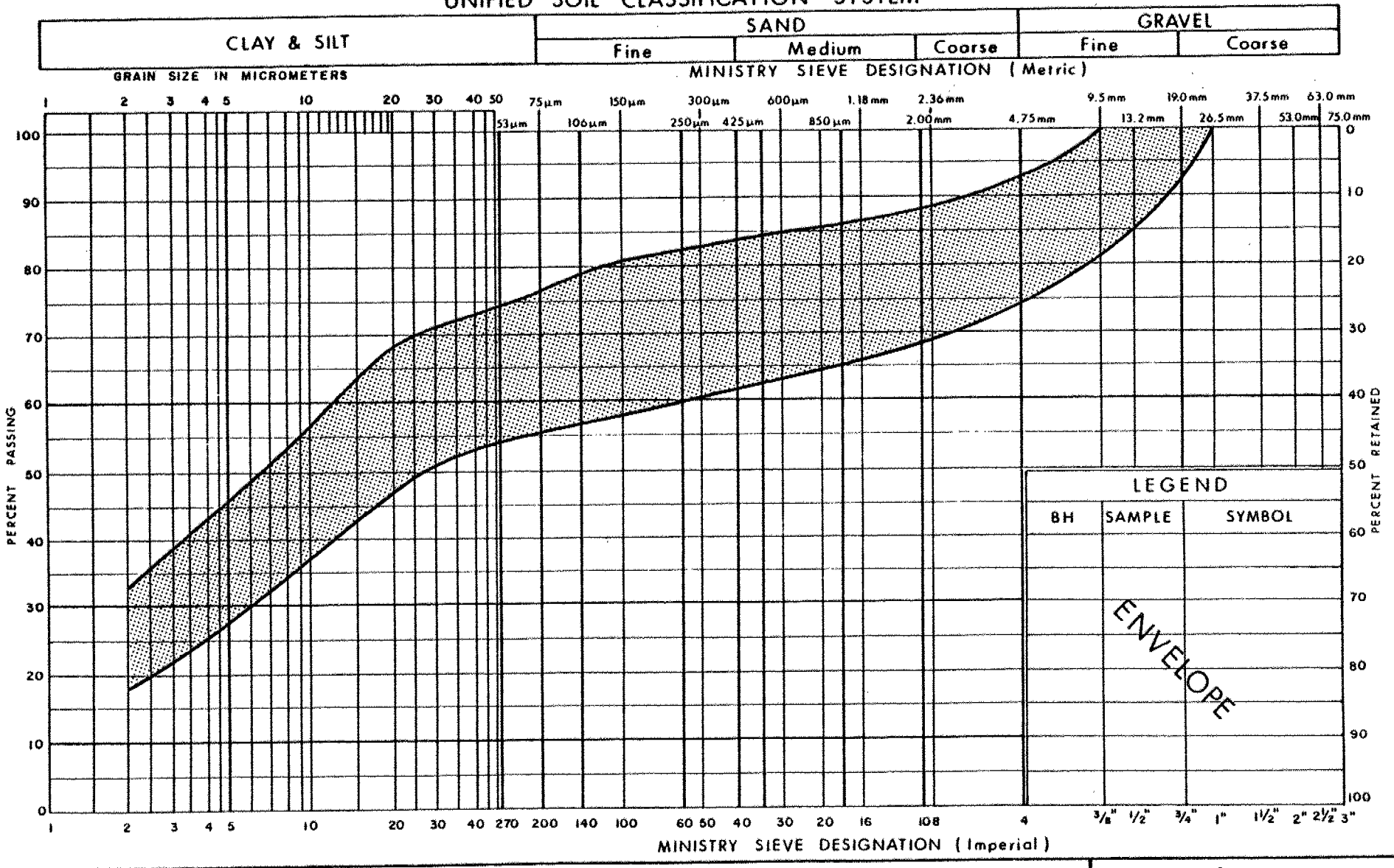
* Note: W.L. not established

x^3, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



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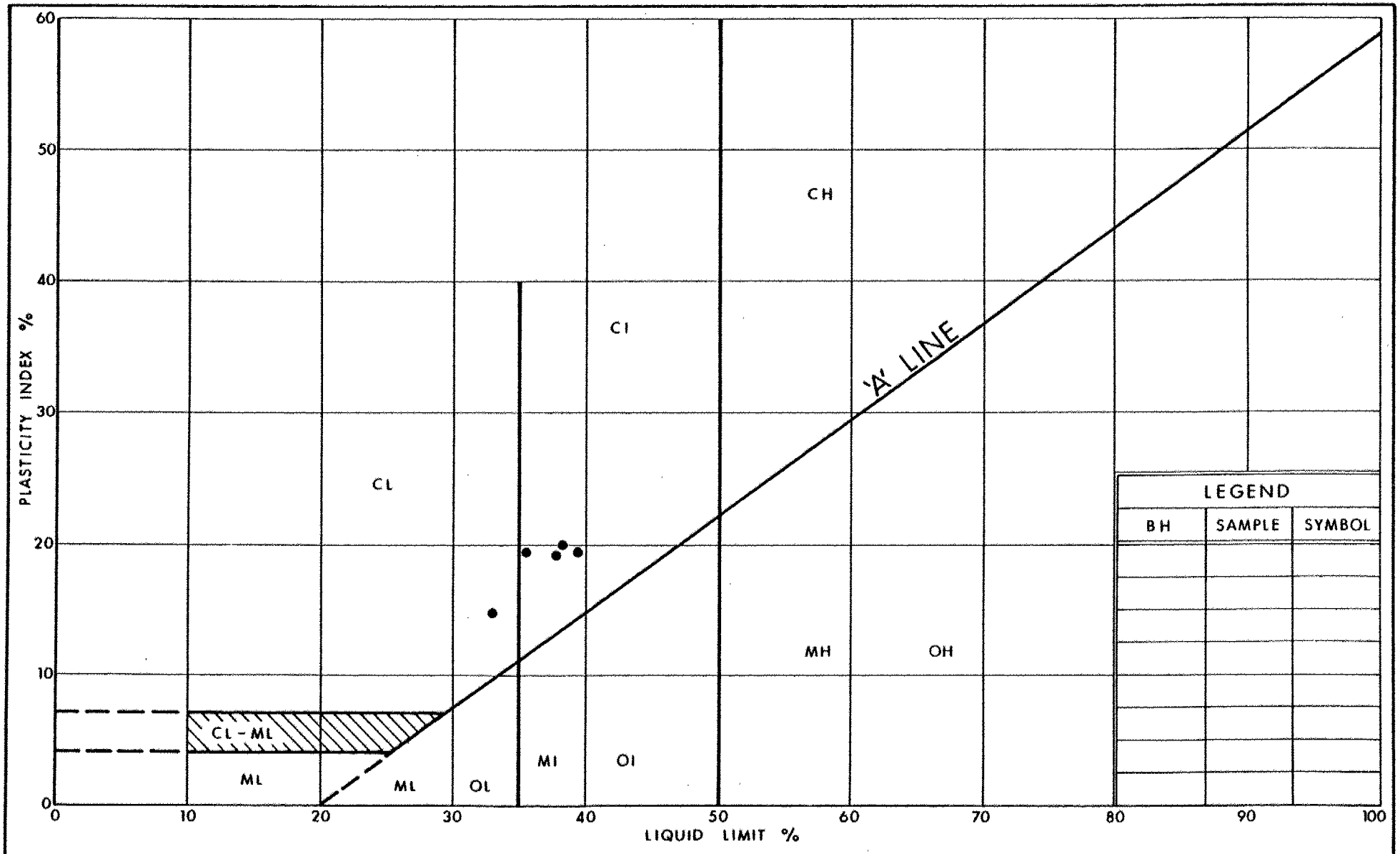
Ontario

GRAIN SIZE DISTRIBUTION
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-27

Oct 75, FF-S-21



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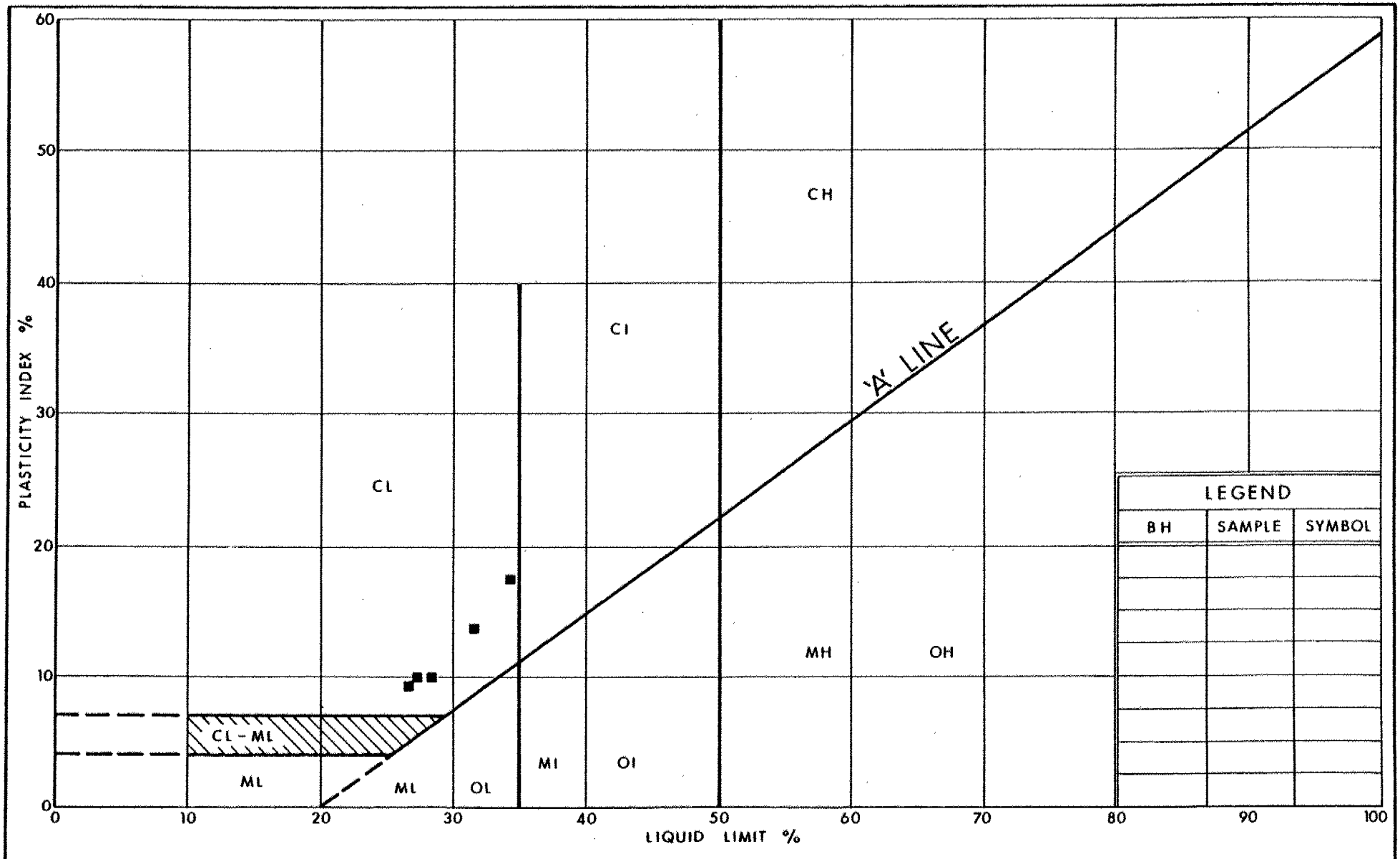
Ontario

PLASTICITY CHART
FILL (Reworked Glacial Till)
SILTY CLAY, SOME SAND VARYING AMOUNTS OF GRAVEL

FIG No 2
W P 127-66-27

Oct 75, FF-S-21



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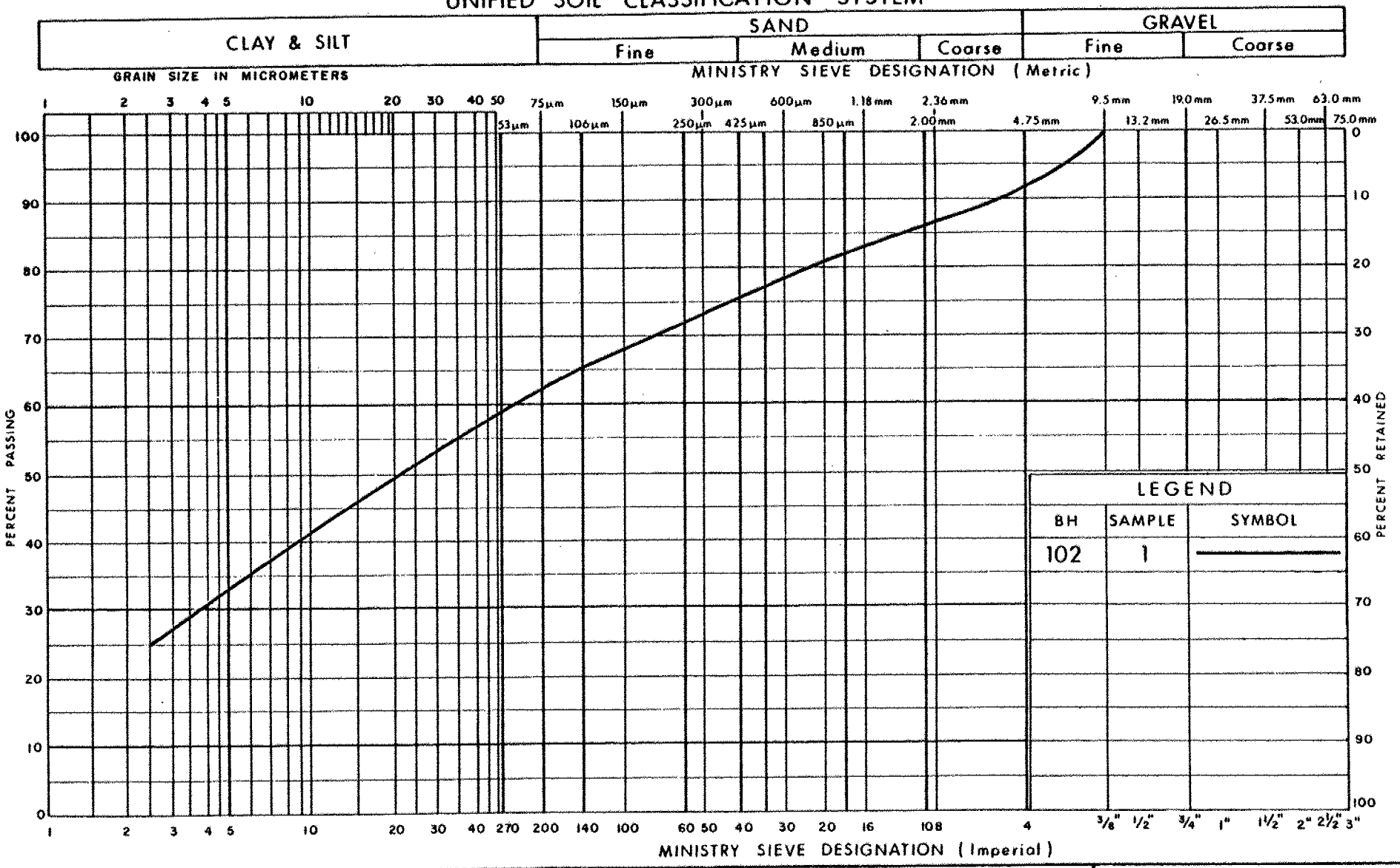
PLASTICITY CHART
Glacial Till – SILTY CLAY Matrix

FIG No 3
W P 127-66-27

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY, SAND & GRAVEL
(Glacial Till)

FIG No 4
W P 127-66-27

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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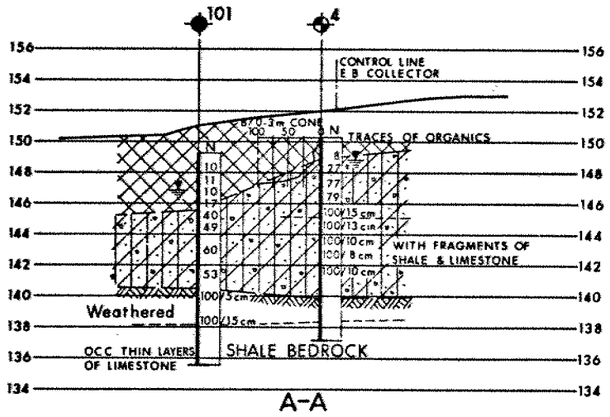
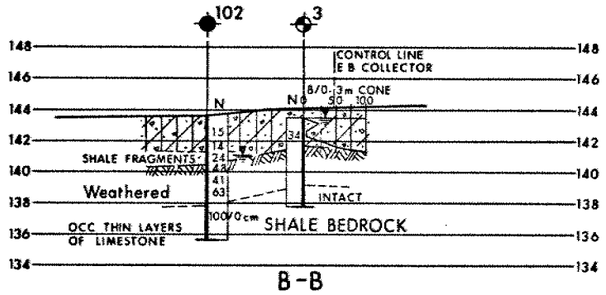
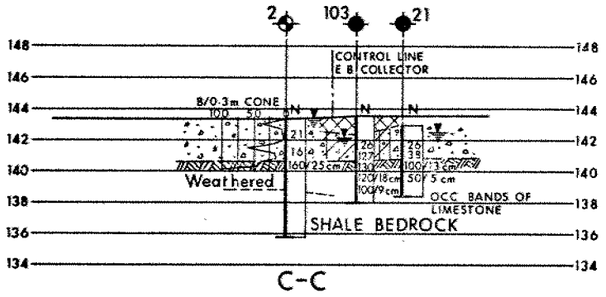


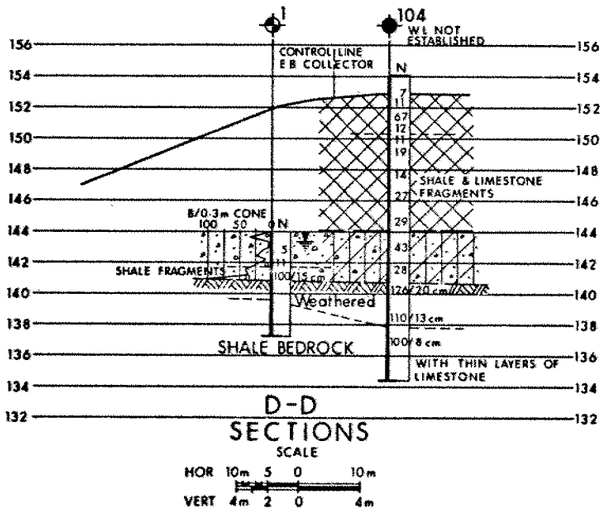
A-A



B-B



C-C



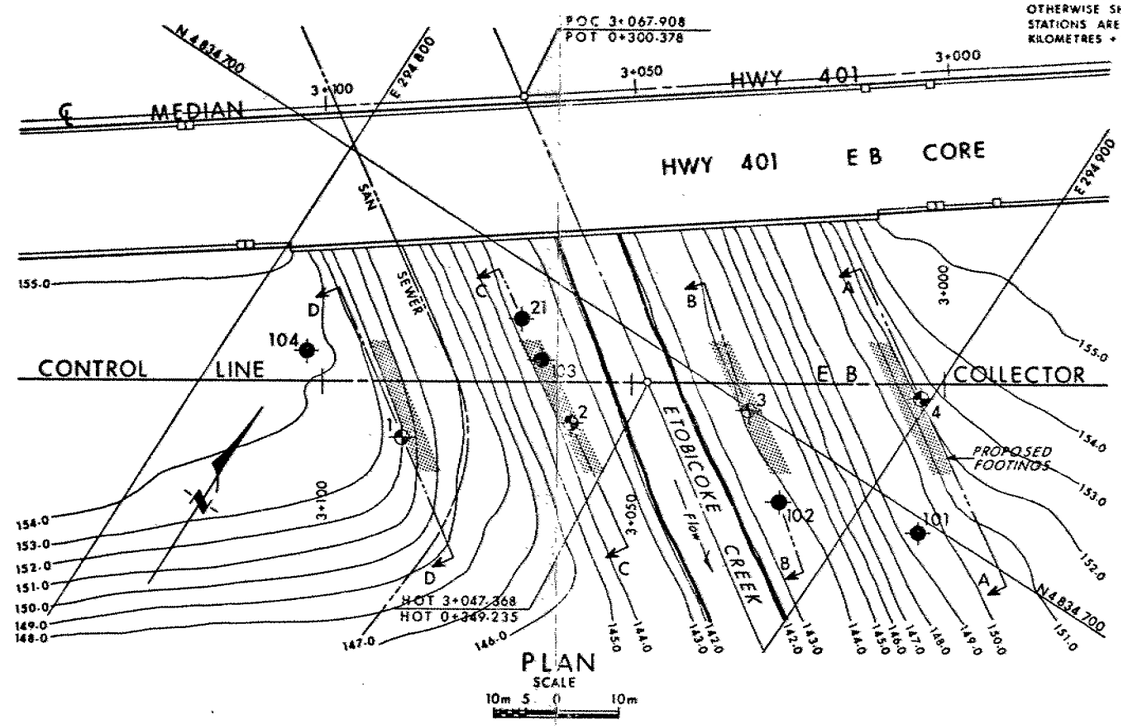
D-D

SECTIONS

SCALE

HOR 10m 5 0 10m

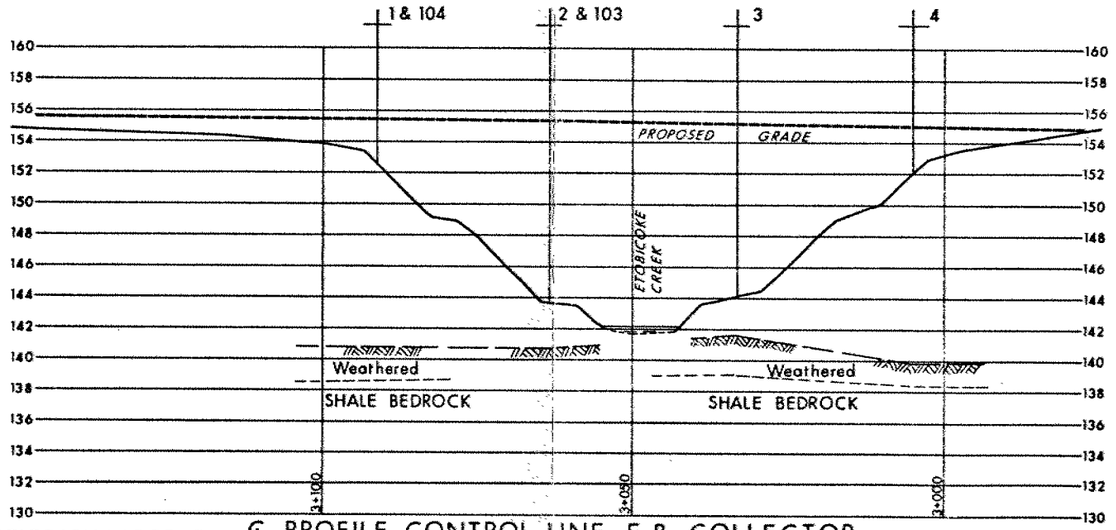
VERT 4m 2 0 4m



PLAN

SCALE

10m 5 0 10m



℄ PROFILE CONTROL LINE E B COLLECTOR

SCALE

HOR 10m 5 0 10m

VERT 4m 2 0 4m

SOIL STRATIGRAPHY LEGEND

FILL, (Reworked Till)
SILTY CLAY, SOME SAND
VARYING AMOUNTS OF GRAVEL
Firm to Very Stiff

SILTY CLAY, SAND & GRAVEL
(Glacial Till) Stiff to Hard

SAND & GRAVEL
TRACE OF SILT & CLAY
Loose to Dense

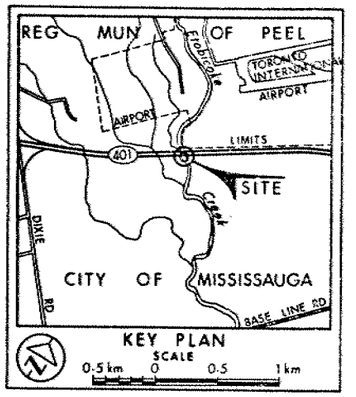
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 127-66-27

HWY 401 E B COLLECTOR OVER ETOBICOKE CREEK (BRIDGE No 8)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0·3m (Std Pen Test, 475 J/blow)
- CONE Blows/0·3m (60° Cone, 475 J/blow)
- WL at time of investigation
  WL for Boreholes 1, 2, 3 and 4 1973 03
  WL for Borehole 21 ; 1973 11
  WL for BH 101, 102 and 103 ; 1982 01
  WL Not Established in BH 104

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	144·0	4 834 665·4	294 832·4
2	143·4	4 834 682·1	294 853·8
3	143·5	4 834 699·5	294 876·6
4	150·3	4 834 715·7	294 898·6
21	143·0	4 834 692·2	294 838·2
101	149·3	4 834 697·7	294 910·0
102	143·6	4 834 690·0	294 888·6
103	143·6	4 834 688·2	294 844·3
104	154·1	4 834 668·8	294 811·7

1973 03 02 to 1973 03 07 — 1, 2, 3, 4
1973 11 14 — 21
1982 01 13 to 1982 01 22 — 101, 102, 103, 104

Elevations for Boreholes 1, 2, 3 and 4 as of 1973 03, for Borehole 21; 1973 11 under WP 127-66-28

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 30M12-154

HWY No 401			DIST 6
SUBMITTED TJK	CHECKED	DATE 1982 04 02	SITE 24 81-184 D
DRAWN	CHECKED	APPROVED	DWG 1276627-A

REF DELCAN Project No 01-1749 Dwg 11